

Utility of Laboratory Tests for Children in the Emergency Department With a First Seizure

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Objective: The objective of the study was to evaluate the factors associated with abnormal laboratory findings in patients visiting the emergency department (ED) after having their first seizure.

Methods: We included ED patients with first seizures and divided them into groups based on normal and abnormal laboratory results for serum levels of sodium, potassium, calcium, and glucose. We evaluated the differences in age, sex, the presence of fever, the presence of gastrointestinal symptoms, the duration and pattern of the seizure, and whether the seizure was still present at the ED.

Results: We evaluated 240 patients. Among them, abnormalities were found in 83 (34.8%) of 238 for serum sodium, 16 (6.7%) of 238 for potassium, 11 (6.2%) of 177 for calcium, and 121 (52.3%) of 231 for glucose. In the serum sodium and calcium group, no differences in associated factors between patients with and without abnormal laboratory results were found. However, results revealed differences in seizure duration between patients with and without abnormal laboratory glucose results ($P = 0.005$) and in age between patients with normal and abnormal potassium results ($P = 0.002$).

Conclusions: There was no significant association among the factors of sex, fever, gastrointestinal symptoms, seizure duration, and seizures in patients who came to the ED with electrolyte abnormalities after a first seizure. However, glucose level abnormalities may have an association with increased seizure duration. We still do not have any suggestions as to which associated factors should be considered when doing common blood examinations in these patients.

Key Words: first seizure, sodium, potassium, calcium, glucose

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Seizures are present in 5% of all patients who come to emergency departments (EDs).¹ Pediatric patients often receive routine electrolyte and blood sugar examinations, because abnormal laboratory findings can potentially determine the causes of a seizure. In the literature, 3.8% to 14.8% of seizure patients who came to the ED had electrolyte abnormalities.² Children who are unconscious after a seizure or have gastrointestinal symptoms such as vomiting or diarrhea have a greater risk of electrolyte imbalance.^{1–6} We conducted a retrospective consecutive study to analyze clinical characteristics of children arriving at the ED after a seizure. We analyzed which predisposing factors were more likely to be associated with electrolyte and glucose abnormalities. In this article, we try to discuss under which clinical conditions laboratory tests need to be done.

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METHODS

The patients in this study were younger than 18 years and came to the ED of Taipei Medical University–Wan Fang Medical Center with a first seizure between January 1, 2000, and July 31, 2009. Subjects in this study received a diagnosis of “seizure” or “febrile seizure” in their medical records if a seizure had prompted the ED visit. Patient age, sex, presence of fever, and gastrointestinal symptoms were recorded as well as the duration and pattern of the seizure and whether a seizure was still present in the ED. Patients with intact clinical records were eligible.

TABLE 1. Demographic Data of Patients With a First Attack of Seizure

	All patients (n = 240)	
	n	%
Age, mean (SD), mo	30.65 (26.06)	
Age group, mo		
≤12	25	10.4
13–24	107	44.5
25–36	51	21.2
37–48	25	10.4
49–60	14	5.8
>60	18	7.5
Sex		
Male	130	54.1
Female	110	45.9
Fever		
Yes	205	85.4
No	35	14.6
GI symptoms		
Yes	23	9.5
No	217	90.5
Seizure at ED		
Yes	27	11.2
No	213	88.8
Seizure type		
GTC	161	67.2
GT	30	12.5
GC	20	8.3
Partial	7	2.9
Other	22	9.1
Seizure duration, min		
<1	23	9.6
1–5	155	64.5
6–10	43	17.9
11–15	8	3.3
16–30	7	2.9
>30	4	1.7

GI indicates gastrointestinal; GTC, generalized tonic-clonic; GT, generalized tonic; GC, generalized clonic.

TABLE 2. Analysis of Patients With First Seizure Based on Different Laboratory Group

Variable	Sodium Group					Potassium Group				
	Normal (n = 155)		Abnormal (n = 83)		P	Normal (n = 222)		Abnormal (n = 16)		P
	n	%	n	%		n	%	n	%	
Age, mean (SD)	30.89 (29.85)		28.35 (16.63)		0.474*	29.18 (26.02)		41.44 (23.58)		0.069*
Age group, mo					0.474					0.002 [†]
<12	19	12.1	6	7.2		25	11.3	0	0	
12–24	69	44.5	38	45.8		104	46.8	3	18.8	
>24	67	43.2	39	47.0		93	41.9	13	81.2	
Sex					0.273					0.727
Male	80	51.6	49	59.0		121	54.5	8	50	
Female	75	48.4	34	41.0		101	45.5	8	50	
Fever					0.106					0.637 [†]
Yes	128	82.6	75	90.4		190	85.6	3	81.3	
No	27	17.4	8	9.6		32	14.4	13	18.7	
GI symptoms					0.992					0.633 [†]
Yes	15	9.7	8	9.6		22	9.9	1	6.3	
No	140	90.3	75	90.4		200	90.1	15	98.7	
Seizure at ER					0.544					0.507 [†]
Yes	19	12.3	8	9.6		26	11.7	1	6.3	
No	136	87.7	75	90.4		196	88.3	15	93.7	
Seizure duration, min					0.677 [†]					0.899 [†]
≤1	17	11	7	8.4		20	8.6	4	25	
1–5	100	64.5	54	65.1		149	67.1	6	37.5	
5–10	24	15.5	17	20.5		38	17.1	3	18.8	
10–15	6	3.9	2	2.4		7	3.2	1	6.2	
>15	8	5.2	3	3.6		8	4.1	2	12.5	

**t* Test.

[†]Mann-Whitney test.

GI indicates gastrointestinal.

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The information for serum levels of sodium, potassium, calcium, and glucose was obtained from paper or electronic records. All of these laboratory tests were performed soon after patients arrived to the ED. Reference ranges for serum electrolytes are defined in *Nelson's Textbook of Pediatrics*.⁷ The reference range of sodium is 135 to 146 mmol/L. The reference range of potassium is 3.5 to 6 mmol/L in 2- to 12-month-old patients and 3.5 to 5 mmol/L in patients older than 12 months. For glucose, the reference range is 60 to 120 mg/dL. The reference range of total serum calcium is 8.8 to 10.8 mg/dL, whereas that of ionized serum calcium is 1.12 to 1.23 mmol/L. The research was approved by the institutional of review board at Taipei Medical University–Wan Fang Medical Center.

Variables of clinical characteristics in patients with normal and abnormal serum chemistries were compared with a χ^2 test, Mann-Whitney test, and *t* test. The differences between groups were considered significant if *P* values were smaller than 0.05. Calculations were done using the Statistical Package for Social Science Software version 12 (SPSS, Chicago, Ill).

RESULTS

Two hundred sixty-three patients who had a first seizure with intact clinical records were evaluated. Among them, 240 patients (91.2%) received laboratory analyses. Table 1 shows the demographic data of 240 patients with a first seizure. The mean value of sodium measured in 238 child patients was 135.3 (SD, 3.1) mmol/L (range, 111–144 mmol/L). Among them, 83

(34.8%) had sodium abnormalities and hyponatremia. The mean value of potassium measured in 238 patients was 4.1 (SD, 0.4) mmol/L (range, 3.1–5.9 mmol/L). Sixteen patients (6.7%) had a serum potassium abnormality. Twelve patients with these abnormal potassium values had a diagnosis of hypokalemia, and 4 had hyperkalemia. Of the 177 children measured for calcium levels, 10 were checked for free ionized calcium (mean, 1.11 [SD, 0.24] mg/dL; range, 0.47–1.33 mmol/L) and 167 for total calcium (mean, 9.3 [SD, 0.5] mg/dL; range, 5.1–10.7 mg/dL). The percentage of patients with serum calcium abnormality was 6.2% (11 patients). Among them, 9 patients had hypocalcemia, and 2 patients had hypercalcemia. Glucose was measured in 231 children, and the mean value was 124.7 (SD, 31.5) mg/dL (range, 22–237 mg/dL). One hundred twenty-one (52.3%) had abnormal glucose values. Among them, most patients had hyperglycemia (*n* = 117, 96.7%), and 4 patients had hypoglycemia. The detailed history of these 4 hypoglycemic patients is as follows. Patient 1, a boy, was 2 years 11 months old. He presented febrile seizure after an upper airway infection. This was a generalized tonic seizure that lasted for 35 minutes. Serum glucose at the ED was 22 mg/dL. Urine ketone was 3+, and ammonia was normal. Brain computed tomography and cerebrospinal fluid analyses were normal. Patient 2, a girl 1 year 4 months old, had a febrile generalized tonic-clonic seizure for 20 minutes after an upper airway infection. Serum glucose at the ED was 31 mg/dL. A brain computed tomography was normal. Mild language delay was found in a further follow-up. Patient 3, a boy,

TABLE 2. Analysis of Patients With First Seizure Based on Different Laboratory Group

Calcium Group					Glucose Group				
Normal (n = 166)		Abnormal (n = 11)		P	Normal (n = 110)		Abnormal (n = 121)		P
n	%	n	%		n	%	n	%	
28.23 (22.28)		22.18 (15.67)		0.377* 0.267 [†]	28.37 (25.91)		31.29 (25.90)		0.394* 0.297
13	7.8	5	45.4	0.069 [†]	15	13.6	9	7.4	0.427
85	51.2	1	9.2		49	44.5	56	46.3	
68	41	5	45.4		46	41.8	56	46.3	
89	53.6	9	81.8		57	51.8	69	57	
77	46.4	2	18.2	0.598 [†]	53	48.2	52	43	0.157
145	87.3	9	81.8		90	81.8	107	88.4	
21	12.7	2	18.2	0.365 [†]	20	18.2	14	11.6	0.114
16	9.6	2	18.2		14	12.7	8	6.6	
150	90.4	9	81.8	0.266 [†]	96	87.3	113	93.4	0.068
17	10.2	0	0		8	7.3	18	14.9	
149	89.8	11	100	0.983 [†]	102	92.7	103	85.1	0.005 [†]
15	9	0	0		14	12.7	7	5.7	
108	65.1	9	81.8		73	66.4	75	62	
31	18.7	1	9.1		22	20	22	17.4	
5	3	1	9.1		0	0	8	6.6	
7	42	0	0		1	0.9	10	8.3	

*t Test.

[†]Mann-Whitney test.

GI indicates gastrointestinal.

was 1 year 1 month old. He took the diabetes mellitus drug, glimepiride, by accident, which caused a generalized tonic-clonic seizure for 10 minutes. Serum glucose at the ED was 43 mg/dL. Patient 4, a girl, was 1 year 10 months old. She had a febrile generalized tonic-clonic seizure after upper airway symptoms. She presented meningeal signs on physical examination. Serum glucose at the ED was 52 mg/dL. Cerebrospinal fluid analysis and an electroencephalogram were normal. All 4 patients had no gastrointestinal symptoms, and they recovered rapidly from hypoglycemia after medical treatment.

Table 2 displays patient characteristics after dividing them into groups by normal and abnormal laboratory results. The patients were grouped by age into 3 groups: patients younger than 12 months, patients 13 to 24 months old, and patients older than 24 months old. Their ages, together with sex and other clinical manifestations (fever, gastrointestinal symptoms, seizure duration, and whether they were having a seizure at the ED), were taken into account when forming these groups.

In the potassium group, the results revealed a significant difference with age ($P = 0.002$). In the glucose group, laboratory abnormality occurred more frequently with prolonged seizure duration ($P = 0.005$).

DISCUSSION

We investigated the associated factors in patients experiencing a first seizure. Hyponatremia, hypernatremia, hypocalcemia, and hypoglycemia are well known to be related to seizures.

In our study, the children in the sodium groups were not found to have significant associated factors, and all of the serum sodium abnormalities were hyponatremia. A serum sodium level of less than 125 mmol/L was regarded as indicating a significant increased risk of seizure activity.⁸ Only 2 patients had serum sodium levels less than 125 mmol/L. Most patients had only mild hyponatremia. In a previous study, hyponatremia was reported in 52% of children with febrile seizure. The study concluded that a mild inappropriate secretion of antidiuretic hormone exists in patients with febrile seizure.⁹ We speculate that the mild hyponatremia seen in our patients was from the same cause.

Table 2 shows that serum potassium, and calcium abnormalities were less frequently found (6.7% and 6.2%, respectively) in our study. This agrees with previous findings.³ Because serum potassium is less related to seizures,⁸ we overlooked the age difference between patients with and without abnormal potassium levels. We found abnormally high serum glucose levels in our patients (52.1%). Our finding is similar to that of Chen et al,¹⁰ who found that, of 319 first-seizure patients, 48% had this abnormality. Another study revealed that only 2.9% (3/102) of hyperglycemic pediatric patients with seizures had high serum glucose levels, but this study set a higher reference range for serum glucose (<250 mg/dL).⁴ This finding suggests that our seizure patients had an increase in circulating catecholamines after their seizures, resulting in increased blood pressure, heart rate, and plasma glucose level.¹¹ This also explains the prolonged seizures associated with a serum glucose abnormality.

Hypoglycemia is often associated with seizures. Few patients (4/240, 1.6%) had serum glucose abnormalities in our study (Table 2), a finding that was compatible with previous studies. Valencia et al² reviewed studies of children with seizures. Hypoglycemia was found in 0% to 0.3% of those with febrile seizures and 0% to 2.9% in unprovoked seizures. We suspect that patient 1 of these 4 hypoglycemic patients had ketotic hyperglycemia. According to a report, ketotic hyperglycemia accounted for 31.4% of all hypoglycemic diagnoses among previously healthy children older than 6 months.^{12,13} After fasting for 12 to 18 hours, the clinical manifestations for our patient were severe hypoglycemia with ketosis.¹² In our opinion, blood sugar levels should be more considerable in seizure patients with prolonged fasting.

A previous study suggested that laboratory examinations are more important in patients with a first seizure who are younger than 2 years,¹⁴ which is why we used this same cutoff point (Table 2). However, we found no difference due to age in our study (Table 2).

Vomiting and diarrhea cause electrolyte imbalance and hypoglycemia. Thus, in standard practice, clinicians are urged to check electrolyte and serum glucose levels when a seizure patient has acute gastroenteritis.³ However, in our study, we did not find a significant association between seizure and gastrointestinal symptoms (Table 2). The result may be because of the mild gastrointestinal symptoms in our seizure patients.

In conclusion, in patients with a first seizure who came to the ED, we found high abnormal rate in serum sodium and glucose levels. All of the serum sodium abnormalities were hyponatremic. We also found that potassium abnormality was associated with an older age and that prolonged seizure duration was associated with glucose abnormality. We still do not have any suggestions as to which associated factors should be considered when doing common blood examinations in these patients.

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